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SOME MEAN CHARACTERISTICS OF CENTRAL NORTH PACIFIC TROPICAL CYCLONES

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PACIFIC REGION
Honolulu, HI
June 1981

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National Weather Service, Pacific Region Subseries

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U. S. DEPARTMENT OF COMMERCE
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NOAA Technical Memorandum NWSTM PR-23

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OF CENTRAL NORTH PACIFIC TROPICAL CYCLONES

Introduction

The compilation of historic tropical cyclone tracks within the area of forecast responsibility of the Central Pacific Hurricane Center (CPHC) at Honolulu covering the Pacific Ocean north of the Equator between 140W and the International Date Line done by Shaw (1981) has produced a valuable data base from which can be computed useful mean values concerning the characteristics of these cyclones. Shaw in his work has assembled data from numerous sources on a total of 99 tropical cyclones covering the period 1832-1979.

Prior to the meteorological satellite era, which began with the launch of the TIROS satellites in 1960, observational data over this part of the Pacific were exceedingly sparse, and most tropical cyclones traversed the area undetected. The few early cyclones in Shaw's listing were mostly hurricanes which came close enough to affect the Hawaiian Islands with strong winds and heavy rains. Other cyclones were detected as ships encountered these storms. Unlike their counterparts in the North Atlantic and over the western North Pacific, these cyclones are usually small but often intense, being embedded in an area of relatively high surface pressure, and as such they easily escaped detection over these sparsely travelled waters which are almost totally void of island stations. Out of the total of 99 cyclones in Shaw's listing, 31 occurred in the pre-satellite era before 1960.

Data Base

In order to include these earlier cyclones into the data set, it was necessary to make certain assumptions about intensities. In general, if a cyclone was reported as a hurricane, it was carried as a minimal hurricane at 65 kts, while the few tropical storm intensity cyclones were carried at 40 kt. Some skewness in the computed average intensities is thus present, particularly in the areas near the Hawaiian Islands where many of these early cyclones were reported.

Since the advent of meteorological satellites in 1960, and particularly since satellites were placed in earth-oriented polar orbits in 1966 and in geosynchronous orbit over the area in 1967, the great majority of tropical cyclones were detected and accurately tracked. A total of 68 out of the 99 cyclones in Shaw's listing occurred in the satellite era since 1960 for an average annual frequency of 3.6 cyclones. Estimates of intensities and changes in intensity are fairly reliably made during this latter period, and many cyclones of weak tropical depression intensity are also included in the 1960's and 1970's.

Procedure

In order to show the spatial variation of tropical cyclone characteristics across the CPHC area of responsibility between 140W and the Date Line, this region was divided into sixty 5-degree squares (Fig. 1). The neighboring "boxes" to the east and west were also included. The northward boundary was taken at 35N since tropical cyclones north of this boundary are few and are a mixture of northward moving weakening cyclones and of east northeastward recurving cyclones from the western Pacific moving at high speed.

Fig. 2 shows the number of cyclones moving through each 5-degree square. Along the edge is a summation by longitude and latitude bands of these numbers. The total population of 99 cyclones make 520 "square crossings." Thus, on the average, a cyclone will move through five squares or roughly a distance of 1500 miles. Many cyclones of course, originate or move outside the CPHC region of responsibility and thus would have longer average tracks. With an average forward speed of 10 kt, a cyclone would traverse 1500 miles in about six days. With the predominantly east to west movement through the region it is easy to see that "heaviest traffic" is between 15N and 20N with a fairly constant flow from the eastern boundary westward to 165W with a rapid drop-off in numbers farther west. This westward flow of cyclones, however, is not as constant as the numbers suggest since many storms decay and new ones develop in a somewhat irregular fashion.

Figure 3 gives some clues to intensity changes across the region. The numbers in each box give the respective number of cyclones that showed increasing intensity (top number), no change (middle number), and decreasing intensity (bottom number) while moving from one box into the neighboring one. There is a tendency for cyclones to weaken or show relatively minor intensity changes while moving westward or northwestward across the region.

Figure 4 gives the average intensity of the maximum sustained winds in knots within each square. The eastern half of the region has relatively more tropical depressions, usually decaying storms, and thus lower average intensities. The area near the Hawaiian Islands may have some bias toward higher intensity values due to the inclusion of the earlier historic hurricanes.

Figure 5 shows the average seasonal time of occurrence. This was computed by assigning a number equivalent to the month and tenth of month of occurrence. A cyclone which occurred around August 1 thus was assigned the value 8.0. September 15 would be 9.5, etc. August is the most frequent time of the year for tropical cyclones over the eastern portion of the area while September occurrences are more likely farther west and north.

Figures 6, 7, and 8 show the average 24-, 48- and 72-hour displacement vector and rate of movement across the area. These values were arrived at by averaging the bearings (degrees) and displacements (n. mi.). The rate of movement in knots was computed by taking the straight line differences between the end points and dividing with the respective number of hours. Since the great majority of storms move along quite regular paths through the region this should give very satisfactory values. The charts show average movements mostly along headings between 280 and 290 degrees across the region with more northward components north of 25N. There is also a slight hint of a trough to the lee of the Hawaiian Islands with a more northward component between 155W and 165W near the islands. The rates of movement show some variation over the region. In general, fastest speed of forward motion is

found between 15N and 20N to the southwest of the Hawaiian Islands. Otherwise, movements near 10 kt seems to be the rule. The faster moving cyclones are usually the weaker developing depressions while intense hurricanes tend to be slower moving. Many of the earlier historic hurricanes did not have reliable 24-hour movement positions and thus were left out of the tabulations. The bearings, however, were utilized.

Summary

The compilation of 99 tropical cyclone tracks traversing the CPHC region of responsibility during the period 1832-1979 done by Shaw gives a valuable climatic data base from which several mean characteristics of these cyclones were computed. The pre-satellite period before 1960 contained 1/3 of the number of cyclones for which, of course, less complete data concerning the exact tracks and intensities were available. As a consequence the data sample is not entirely homogeneous but enough data can be extracted to give some useful information concerning these cyclones.

Reference: Shaw, S. L., 1981: A History of Tropical Cyclones in the Central North Pacific, 1832-1979. (Submitted for publication).

FIG. 1. 5-DEGREE SQUARE GRID

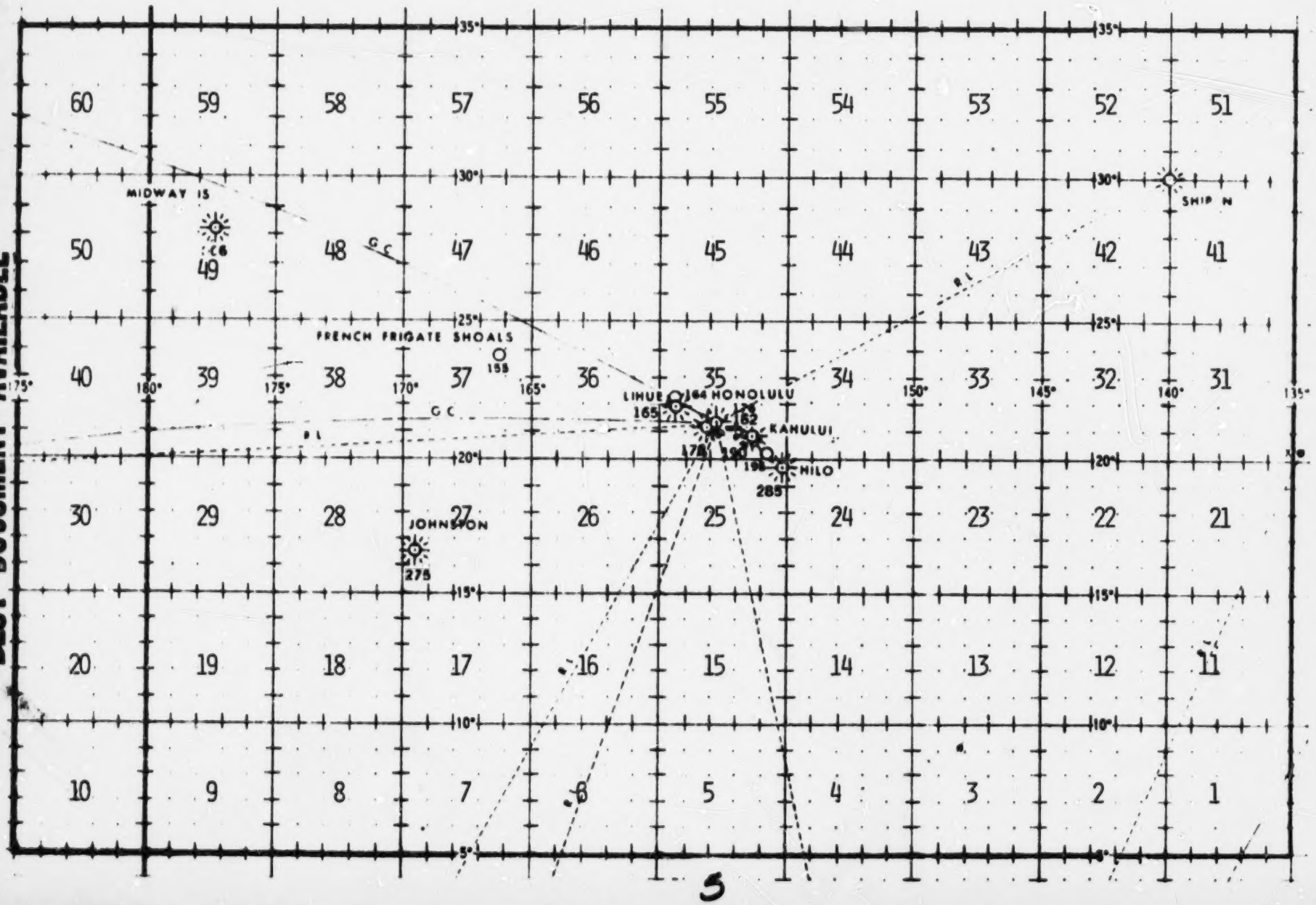

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FIG. 2. NUMBER OF RECORDED TROPICAL CYCLONES
MOVING THROUGH EACH SQUARE DURING PERIOD 1832 - 1979

(SUMMATION BY LATITUDE AND LONGITUDE BANDS
IN PARENTHESIS ALONG MARGIN)

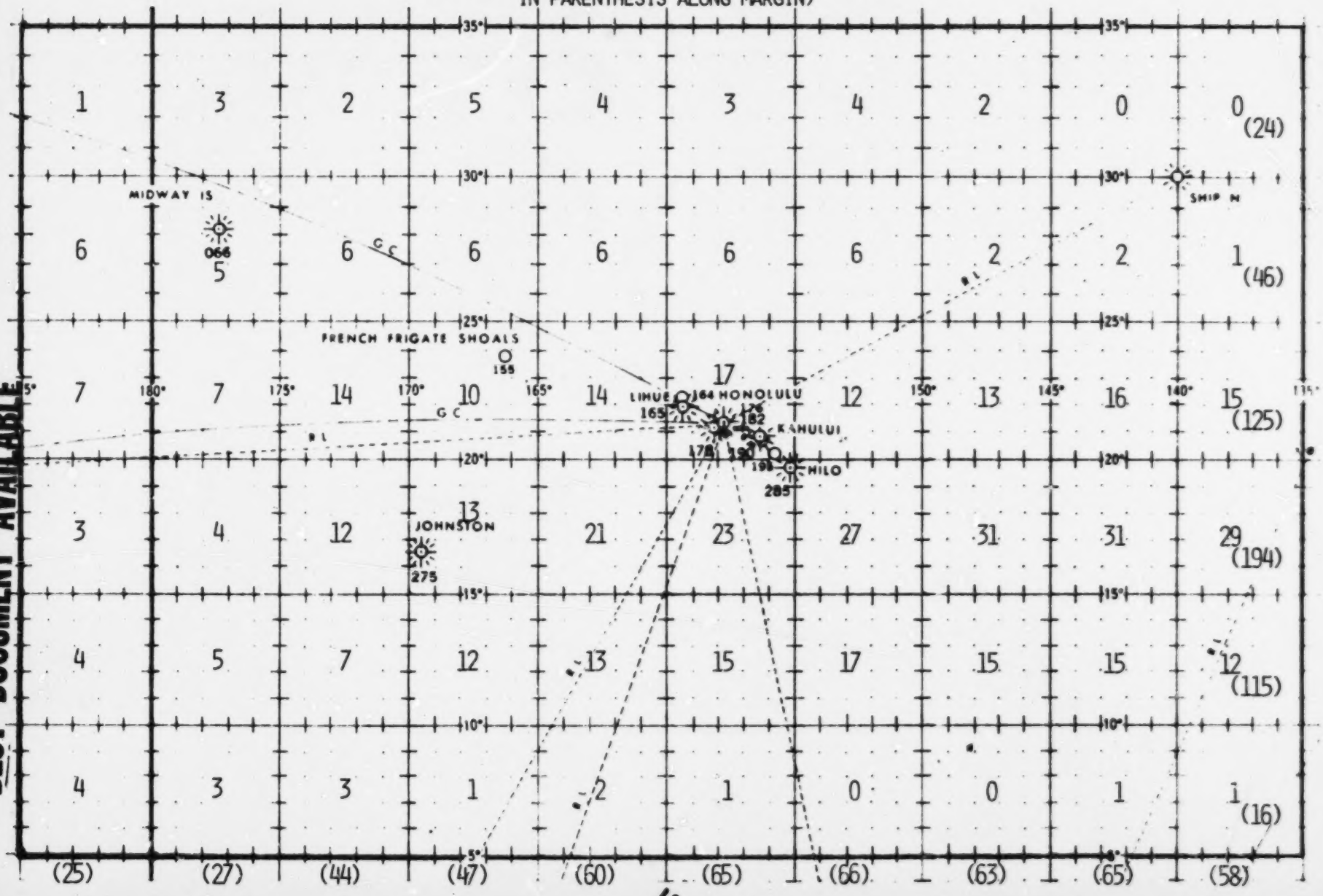

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FIG. 3. NUMBER OF TROPICAL CYCLONES SHOWING (INCREASE / NO CHANGE / DECREASE) IN INTENSITY UPON ENTERING SQUARE

(SUMMATION BY LATITUDE AND LONGITUDE BANDS IN PARENTHESIS ALONG MARGIN)

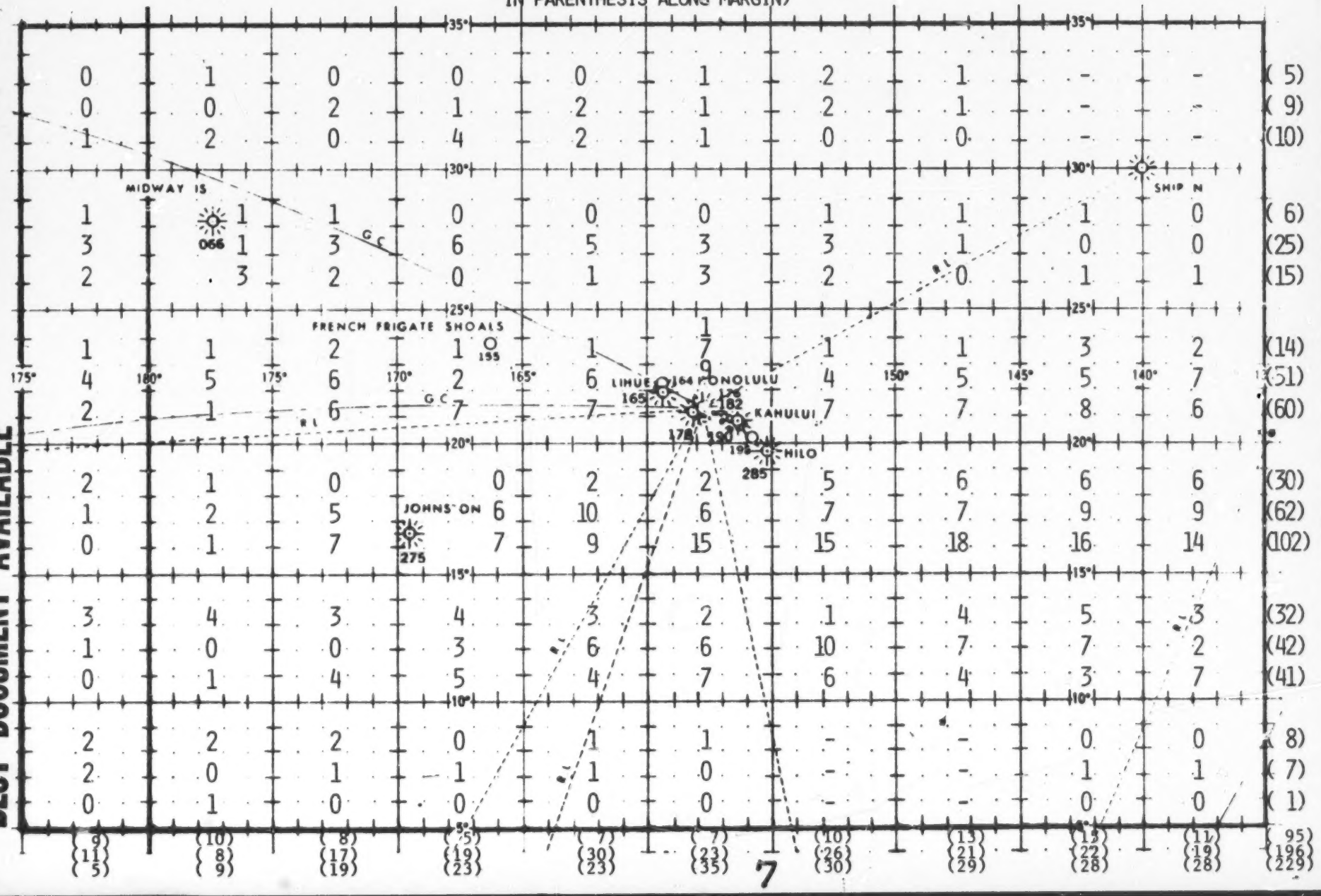

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FIG. 4. AVERAGE INTENSITY OF TROPICAL CYCLONES IN SQUARE.
MAXIMUM SUSTAINED WINDS IN KNOTS.

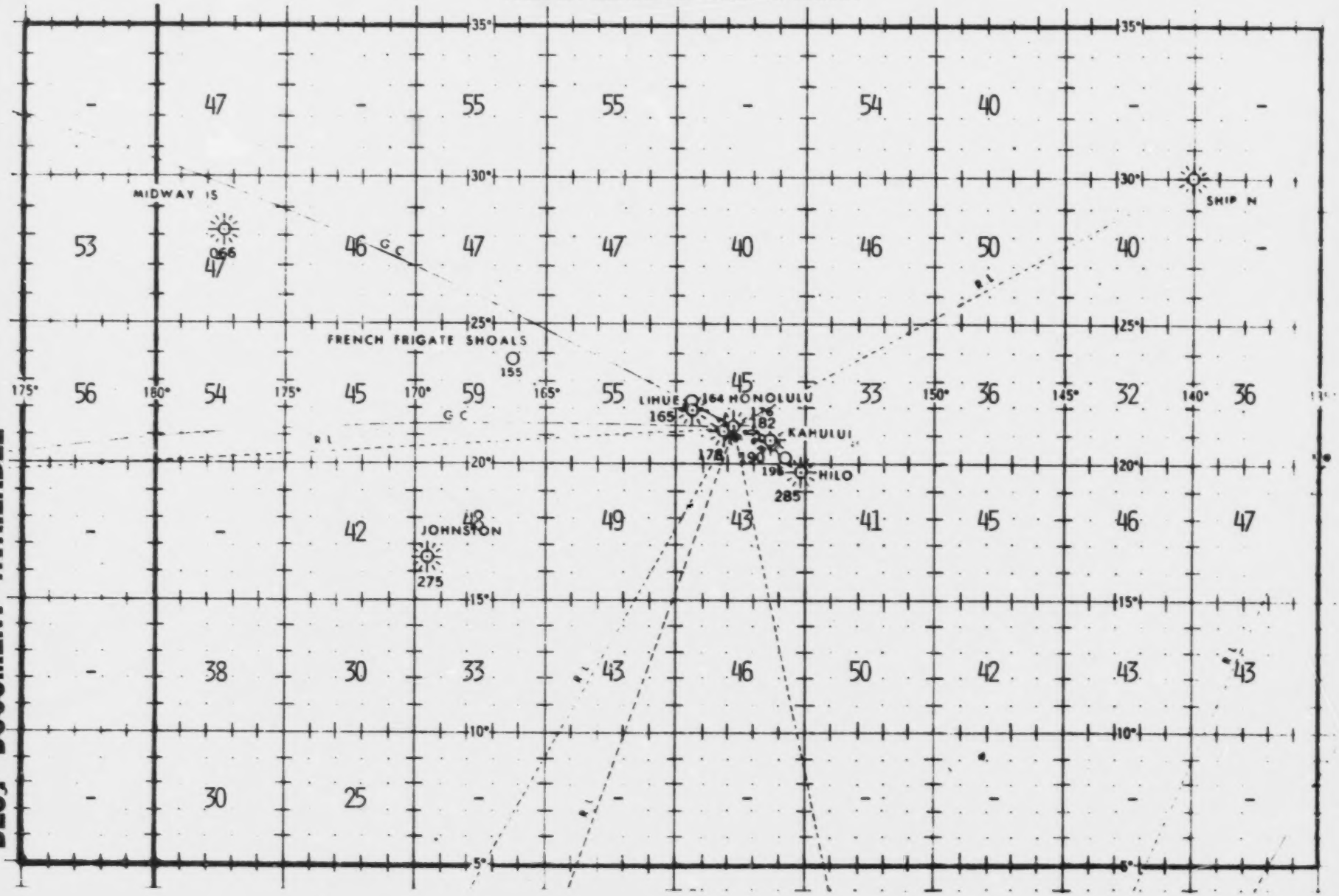

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FIG. 5. AVERAGE SEASONAL TIME OF OCCURRENCE OF TROPICAL CYCLONES
(8.0 = AUG 1, 8.5 = AUG 15, ETC.)

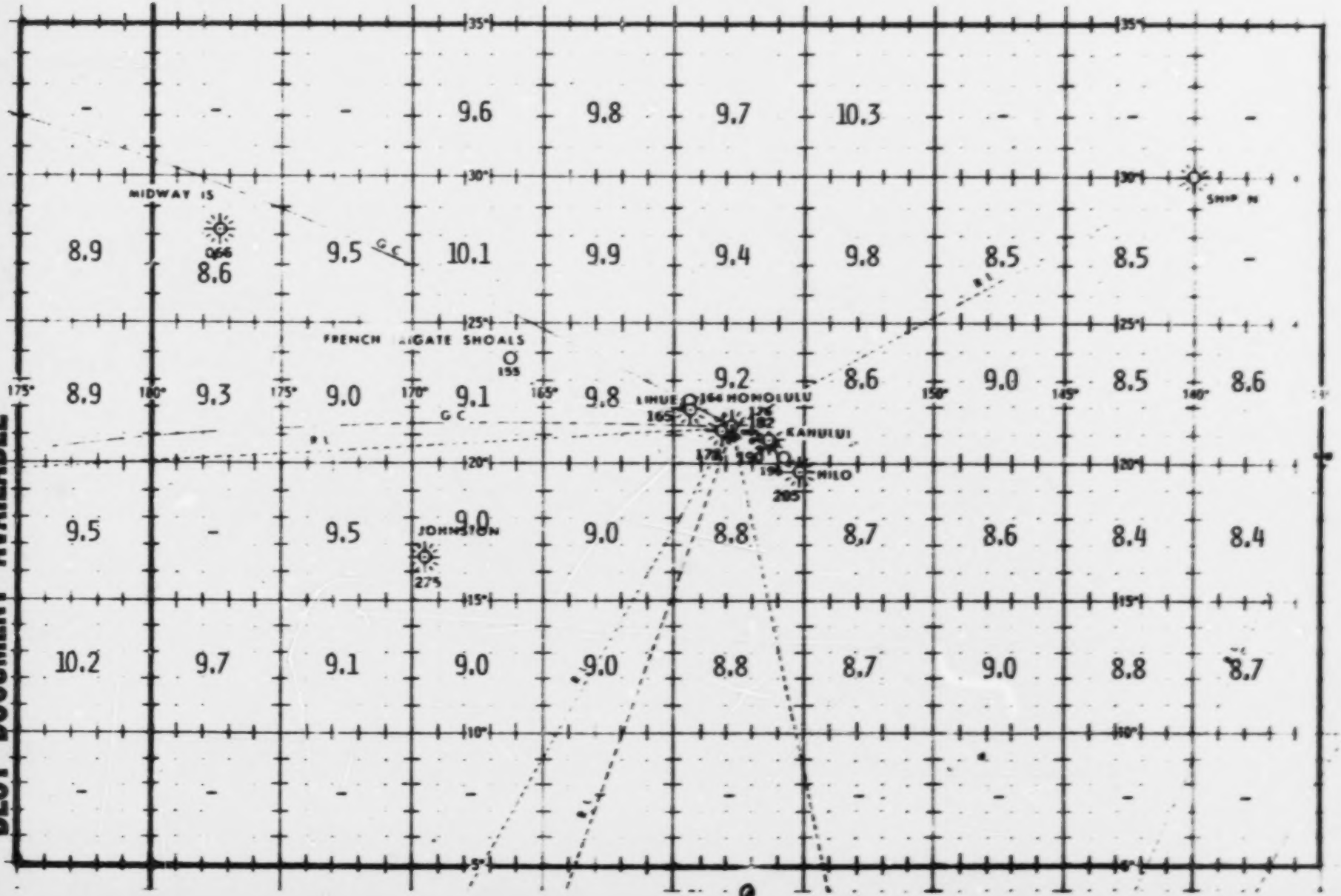

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FIG. 6. AVERAGE 24-HOUR DISPLACEMENT VECTOR AND RATE OF MOVEMENT

BEARING (DEGREES)
DISTANCE (N. MI.)
RATE OF MOVEMENT (KT.)

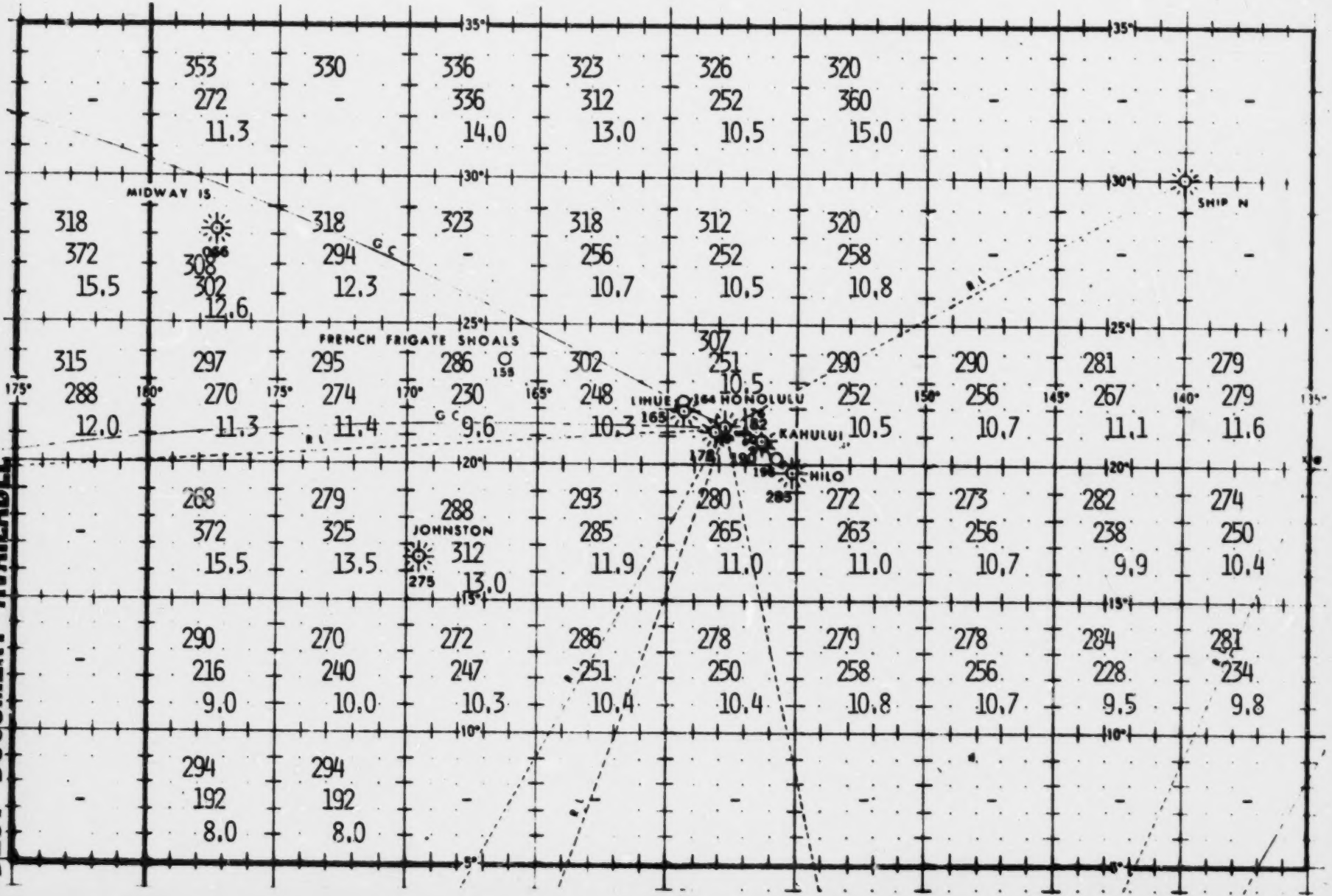

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FIG. 7. AVERAGE 48-HOUR DISPLACEMENT VECTOR AND RATE OF MOVEMENT

BEARING (DEGREES)
DISTANCE (N. MI.)
RATE OF MOVEMENT (KT.)

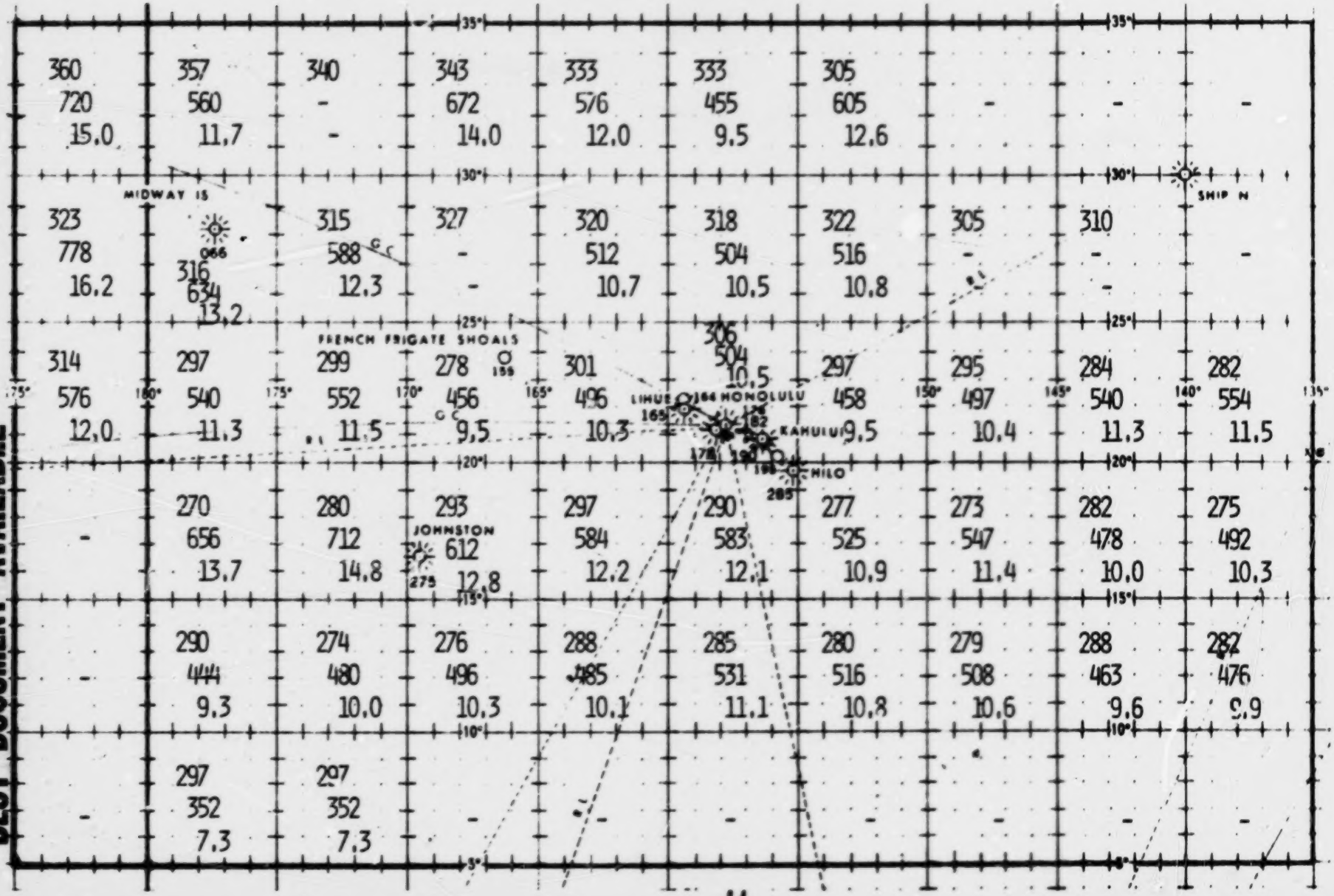

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FIG. 8. AVERAGE 72-HOUR DISPLACEMENT VECTOR AND RATE OF MOVEMENT

BEARING (DEGREES)
DISTANCE (N. MI.)
RATE OF MOVEMENT (KT.)

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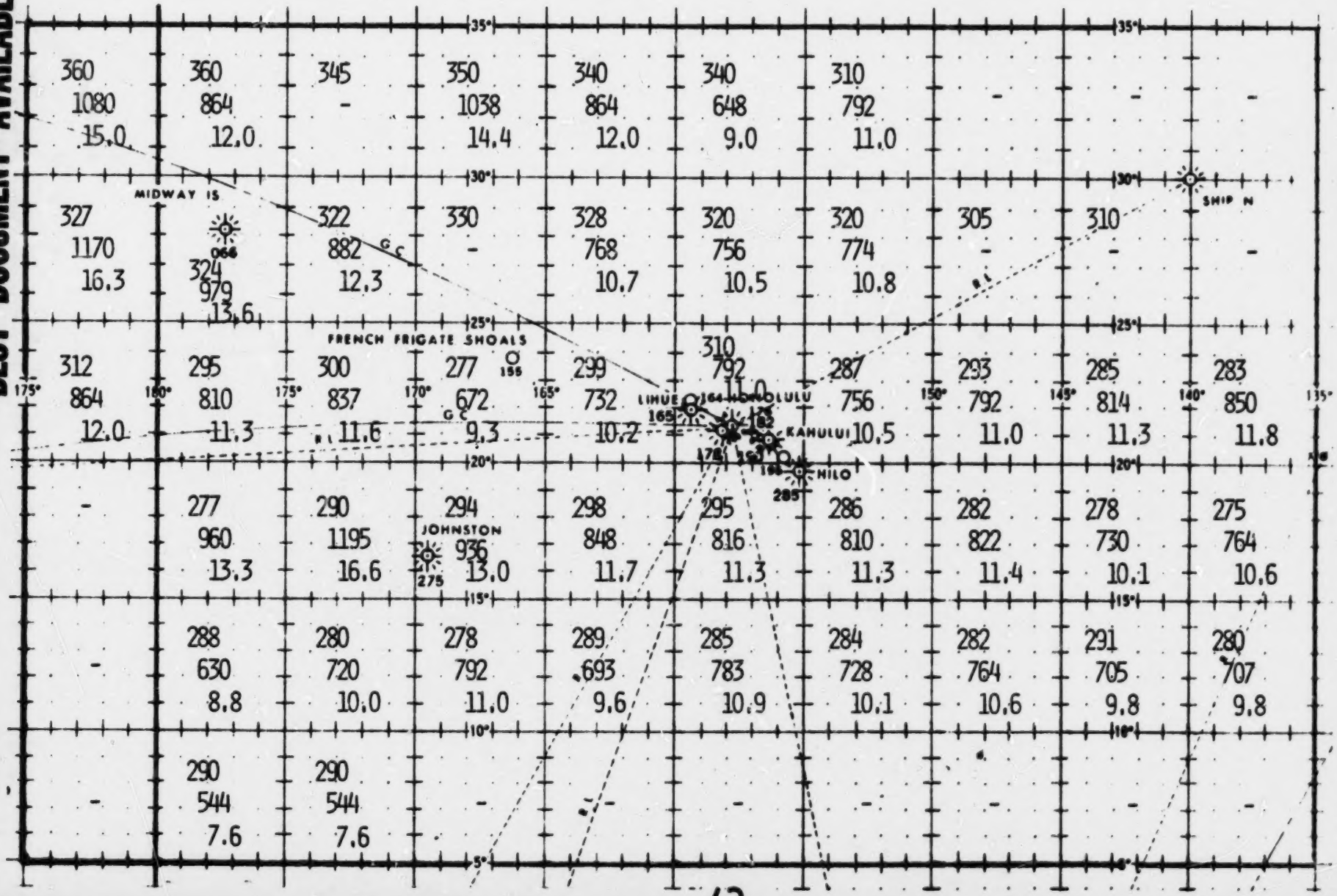

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